

**BI-ANNUAL DOD JOINT COMMITTEE ON TACTICAL SHELTERS (JOCOTAS) MEETING &  
OUTDOOR EXHIBITION WITH THE SOFT & RIGID WALL SHELTER**

**May 2-4, 2005**

**Reactive Coatings as a Protective Shelter Liner Against CB  
Agents**



**Dr. Joseph D. Wander  
Jeffery R. Owens  
Timothy T. Lewis  
Rashelle S. McDonald**

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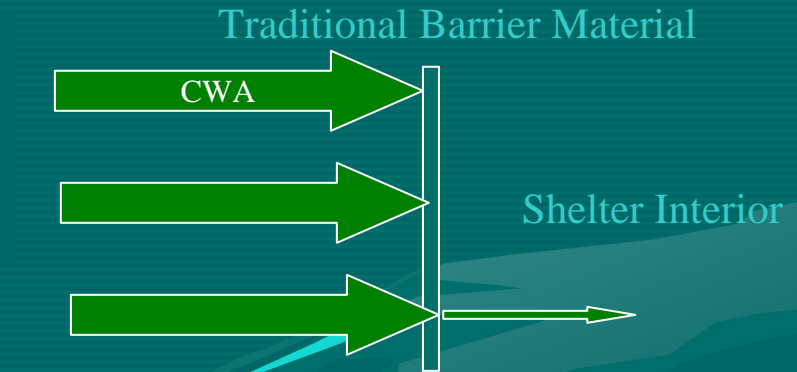
# Order of Operation

- Introduction
- Theory
- Criteria for Success
- Background
- Coating Comparison
- Summary and Conclusions
- Questions

# Reactive Treatments/Coatings for Collective & Individual Protection

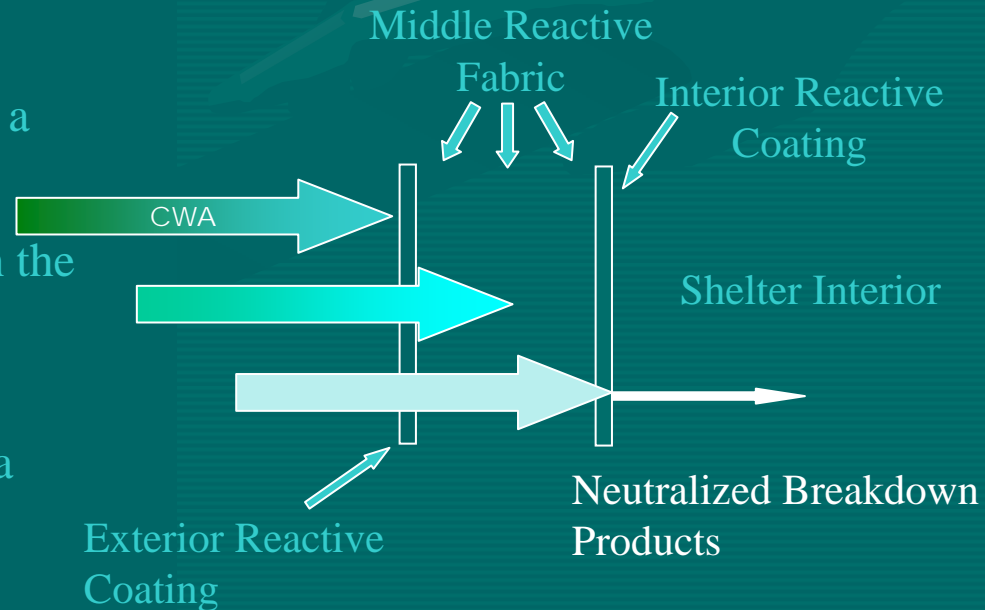
## Conventional Barrier Materials

- All present barrier materials will fail over time
- Better barrier materials => to higher costs



## Reactive/Barrier Materials

- Neutralization products at the surface act as a prophylactic
- Only neutralized products permeate through the reactive barrier component
- Shelter materials can be used to make less expensive barrier materials augmented with a reactive coating



[Link to Back-ups](#)

# Criteria for Success

- Reactive system chemically active to the target C/BWA
- Reactive system compatible with proposed polymer system w/o significant loss of chemical reactivity
- Products considerably less toxic than CWA targets
- Favorable stoichiometry of reactive system vs CWA target
- Permeation kinetics must be slower than reaction kinetics
- Ideally catalytic or capable to regenerate

# How Neutralization Occurs

## Neutralize Bugs

- cell toxicity
- membrane disruption
- oxidation

## Neutralize VX

- oxidation
- hydrolysis
- nucleophilic attack

## Neutralize G-agents

- hydrolysis
- nucleophilic attack

- oxidation
- hydrolysis

## Neutralize HD

# What We Want



**Neutralizes  
G-agents**

**Neutralizes  
VX**

**Neutralizes  
Bugs**

**Neutralizes  
HD**

**?  
Unknown**

# Technical Approach

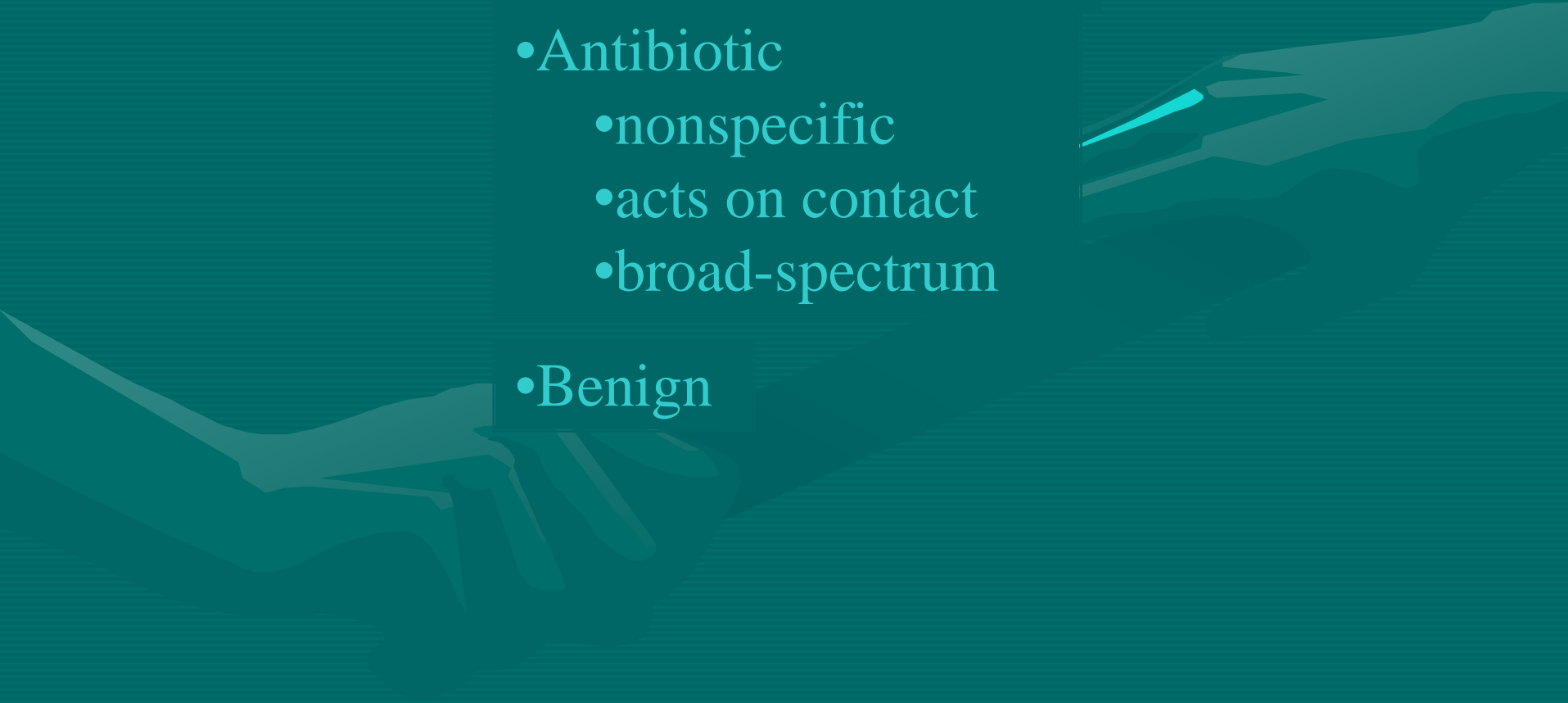
Weak oxidizers within a band of reactivity that targets specific functional groups

## Chloramides



# Why Chloramides?

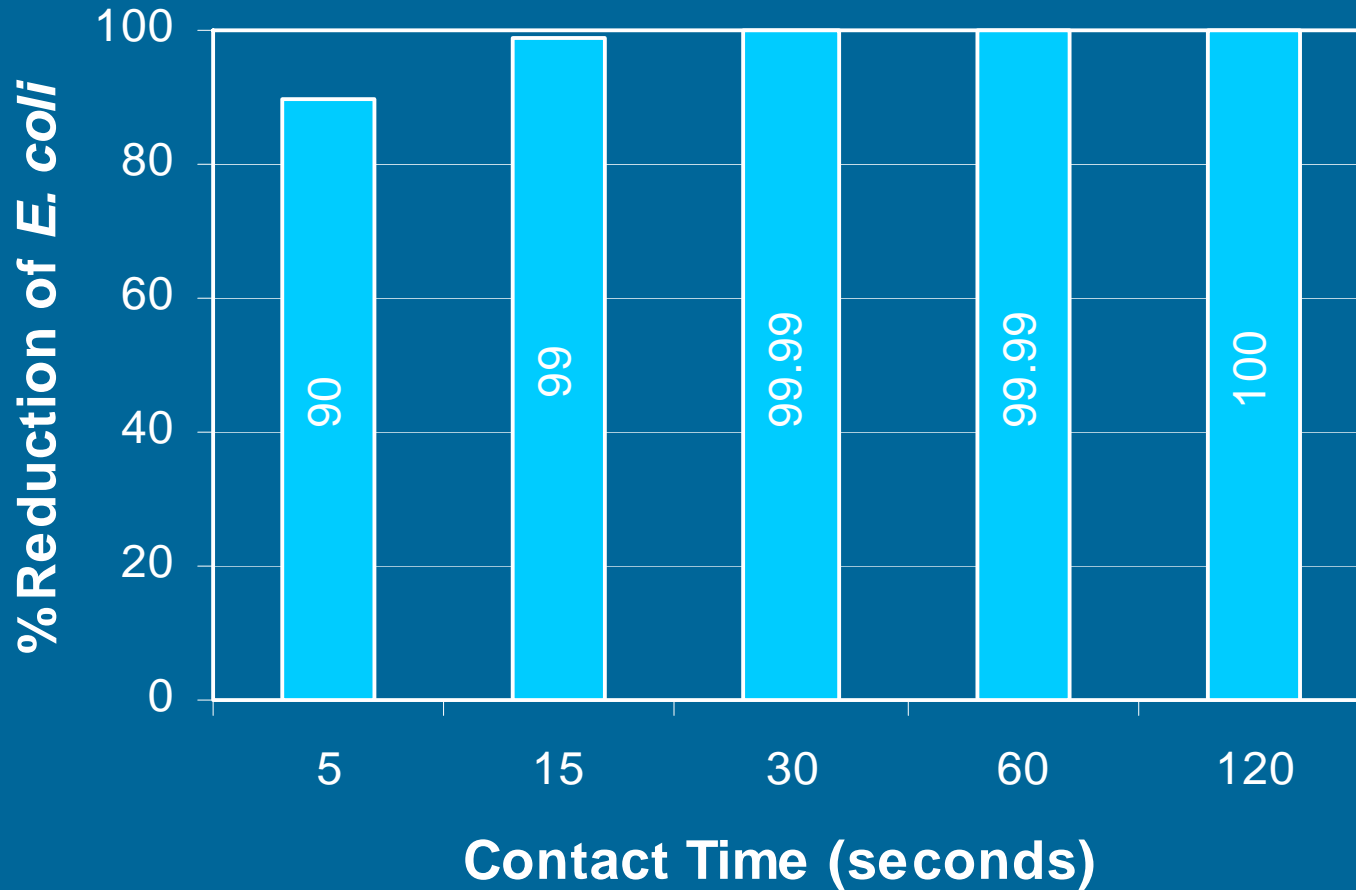
- CWA decontaminant
- Antibiotic
  - nonspecific
  - acts on contact
  - broad-spectrum
- Benign



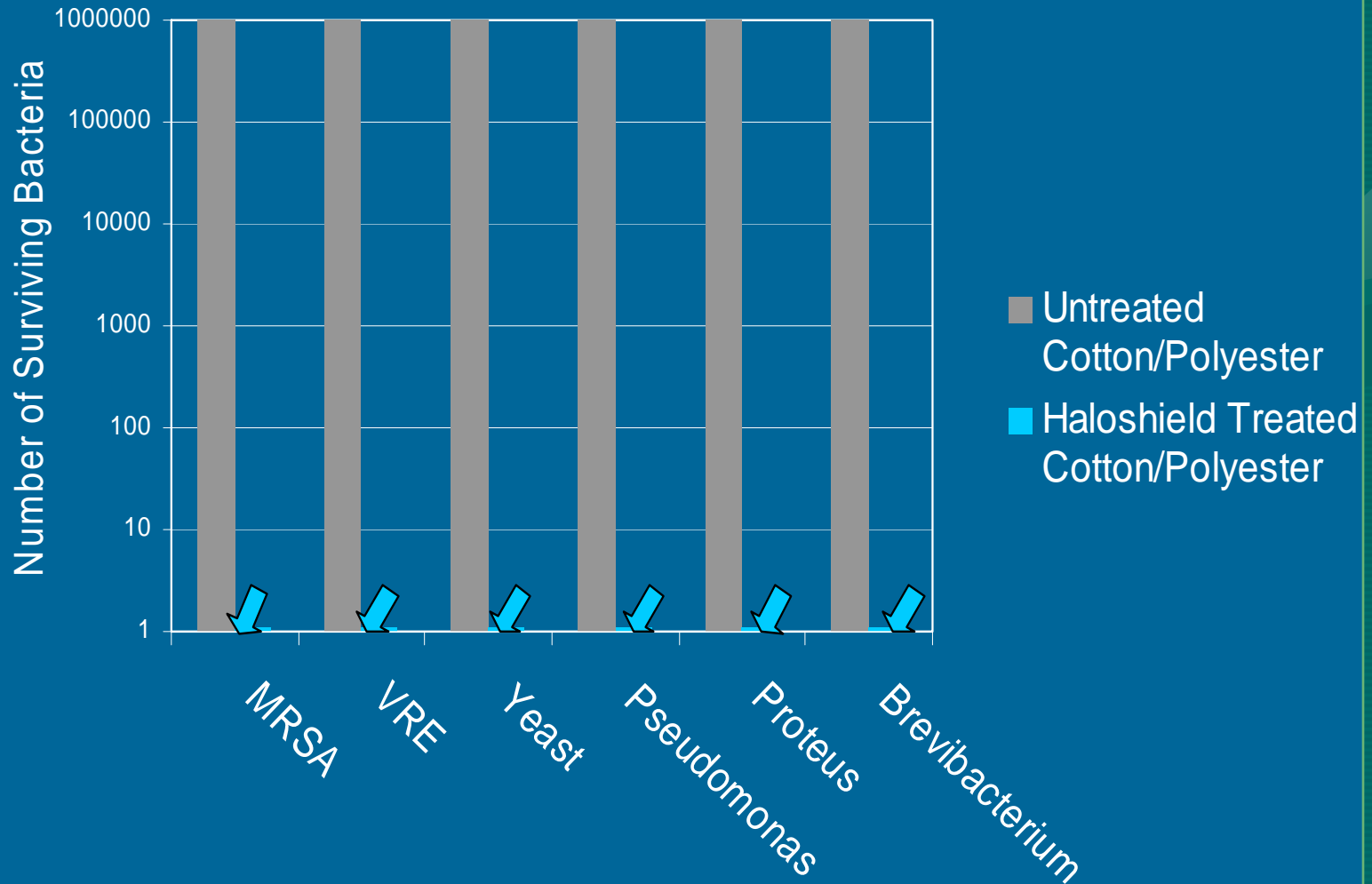
# Progressive Approach to Reactive Barrier

- Establish Biocidal Efficacy
- Challenge Broad Spectrum of Organisms
- Challenge Spores
- Challenge Chemical Simulants
- Incorporate into Coatings

# Chloramides: Fast Acting Biocides



# Chloramides: Broad Spectrum Biocide



After two minutes exposure

# Chloramides Challenging Spores

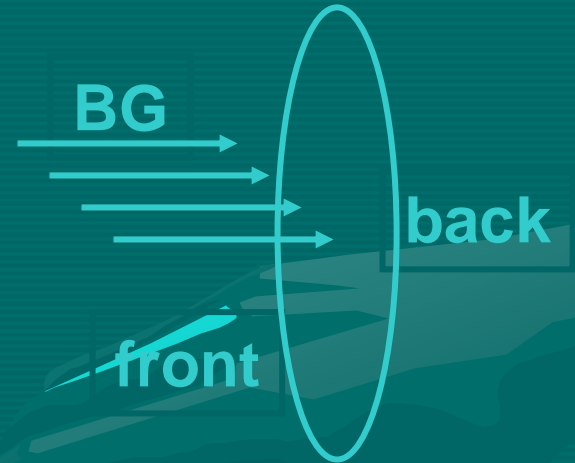
(Compliments of Natick)

## AEROSOL CHALLENGE TEST

BG Spores, 10 min flow

525-675K Spores, 1 hr Incubation

Plate Back Surfaces and Count



## RESULTS

	Penetration	Front	Back
SAMPLE	(%)	(counts)	(counts)
Shell/Espun	3.0	36,000	1,150
Shell/Espun/Chloramine	2.7	29,000	720
Shell/Coated/Chloramine	9.6	1,610	0

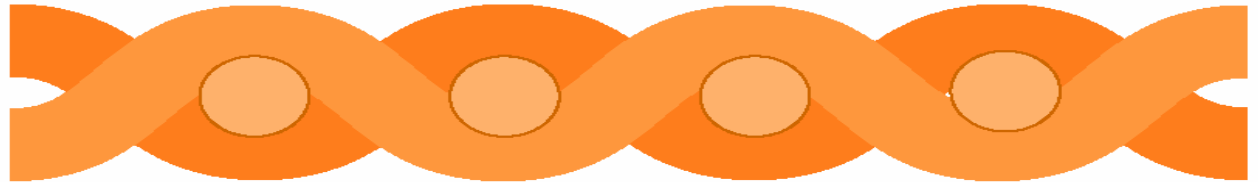
# Chloramides: Practical Environment



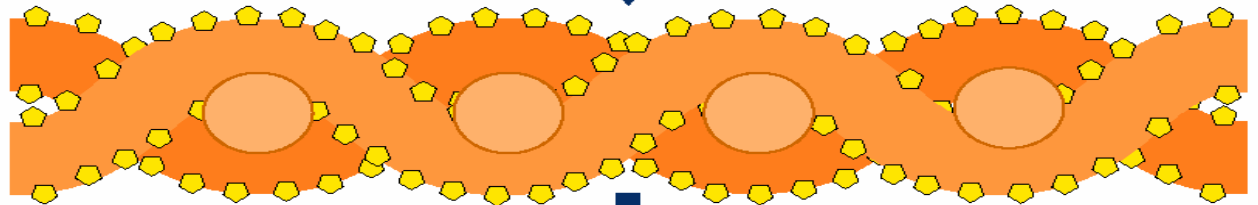
- reactivity regenerates with  $\text{Cl}_2$  concentrations of  $<10$  ppm
- zero colony formation from a *Pseudomonas pseudoalcaligenes* JS45 challenge after three, six, nine and twelve months w/o recharging

# Grafting/Activating Reactive Sites to Cellulose Fibers

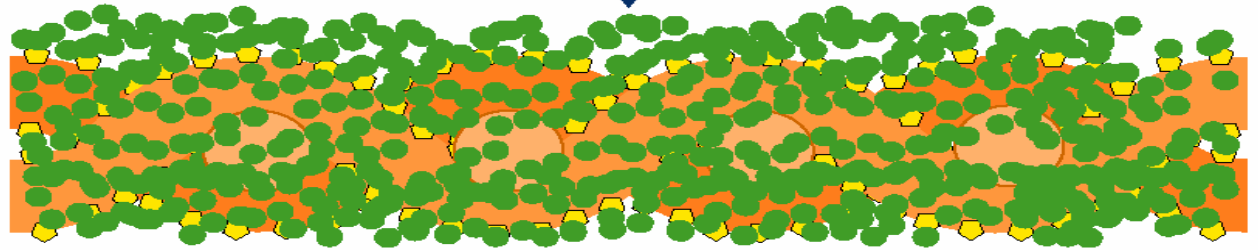
**Untreated Fiber**



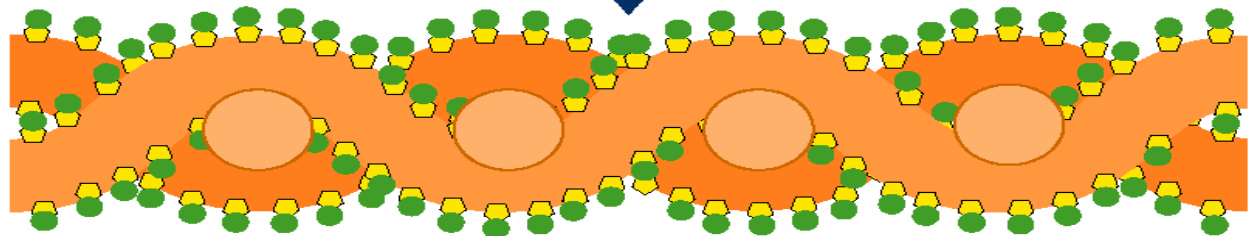
**Treated Fiber**



**Chlorine Bleach Wash**

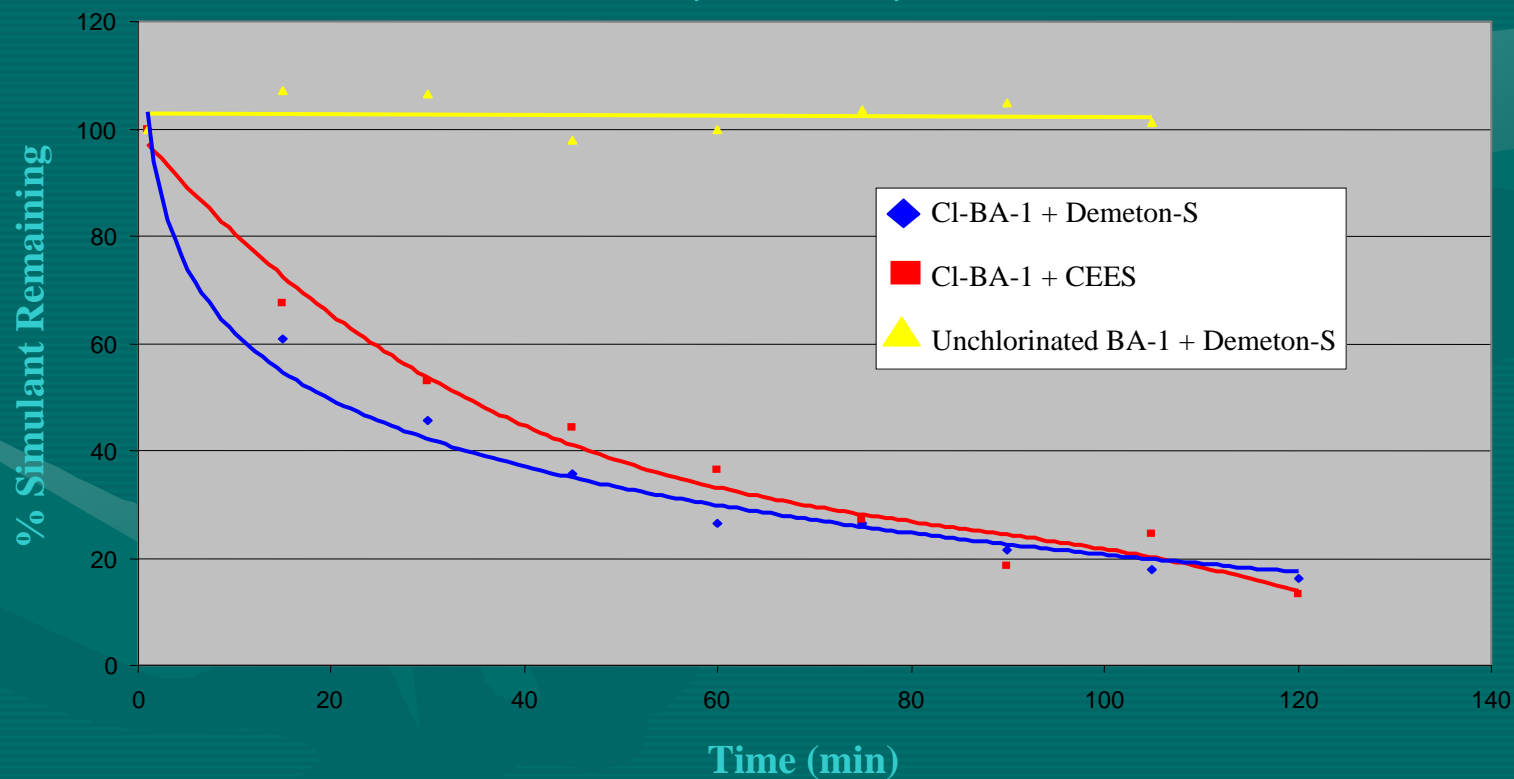


**Chlorine Molecule Anchored to the Fiber**



# Chloramide Reactivity to CEES: Agent Simulant

Oxidation of Chemical Agent Simulants by  
Chlorinated BA-1 Fabric  
(In Acetonitrile)



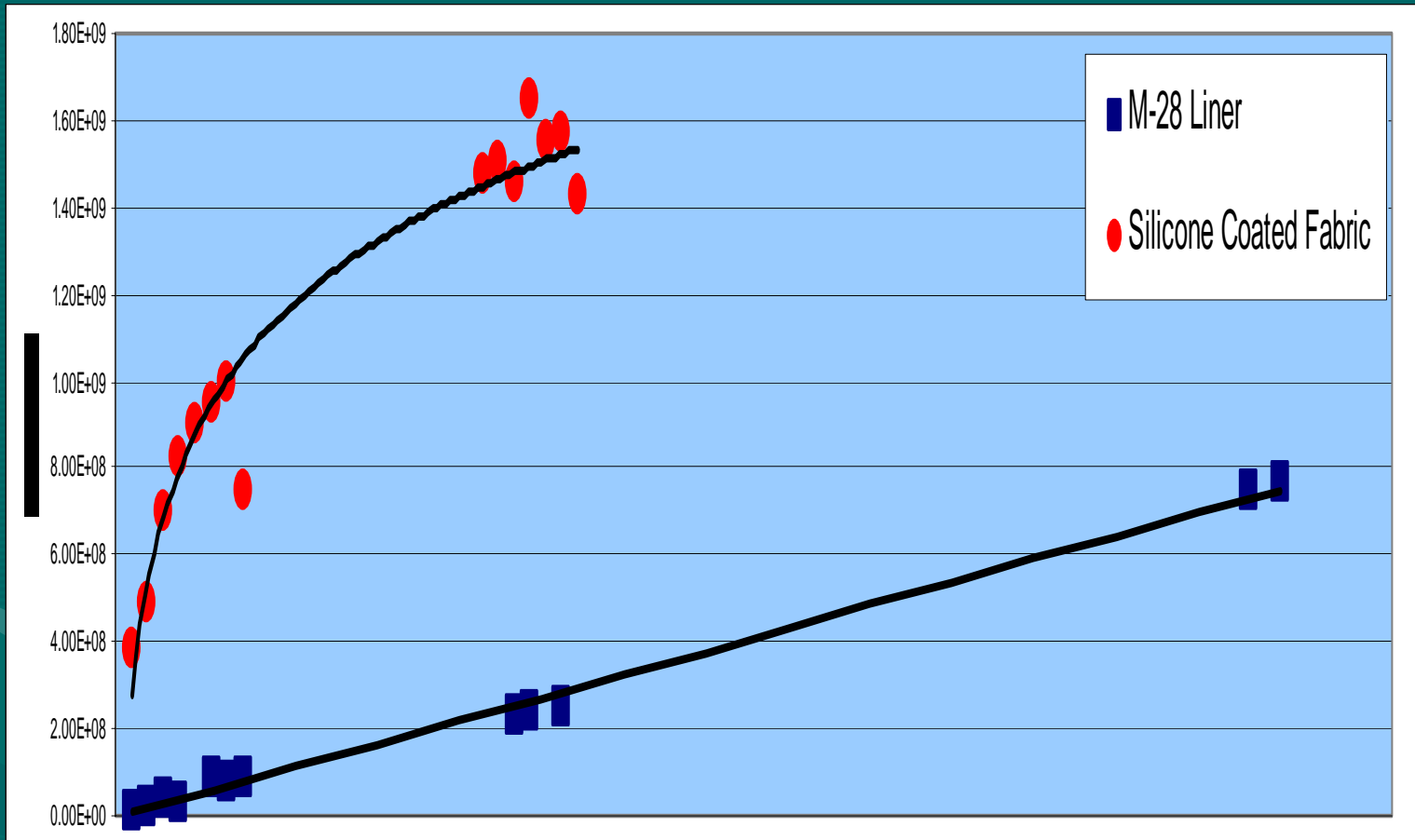


# The Reactive Coating System

- Fabric- 600 thread count, 100% cotton sateen  
Manufacturer: Hotel Fine Linens
- Silicone Coating- Ultra Guard 5500®, single component silicone elastomer  
Manufacturer: General Coatings, Inc.
- Fluorinated Silicone Coating- Dow Corning® 94-003, single component fluorinated silicone elastomer  
Manufacturer: Dow Corning
- Experimental chloramine monomers: DC, MC, BA-1, poly-TTDD  
Synthesized by: Auburn University
- Reactive System = Silicone coating with Chloramine (10% wt/wt) coated onto chloramine treated 600 count cotton fabric

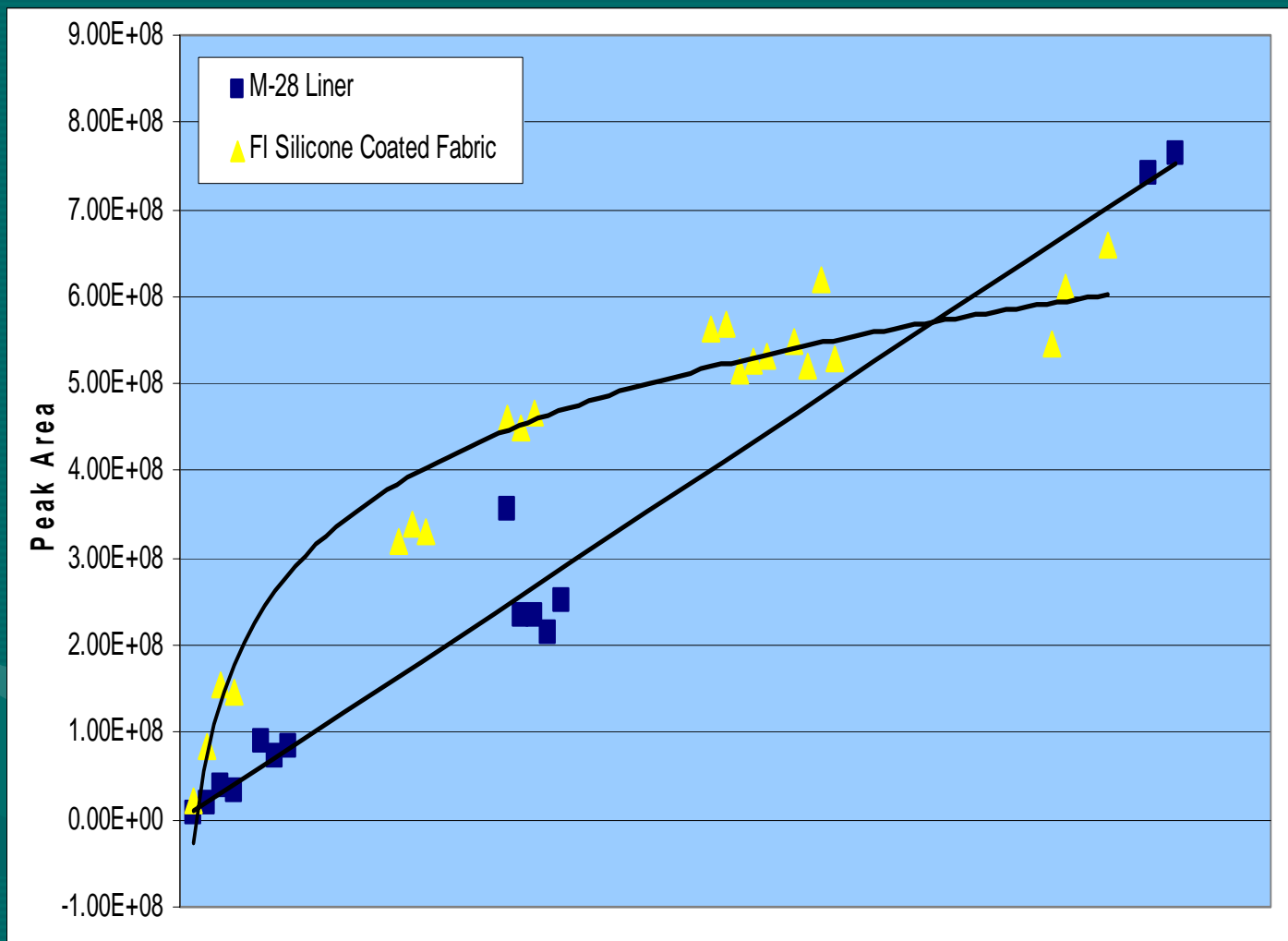
# M-28 Liner vs Silicone Coated Fabric: CEES

20g/m<sup>2</sup> Challenge



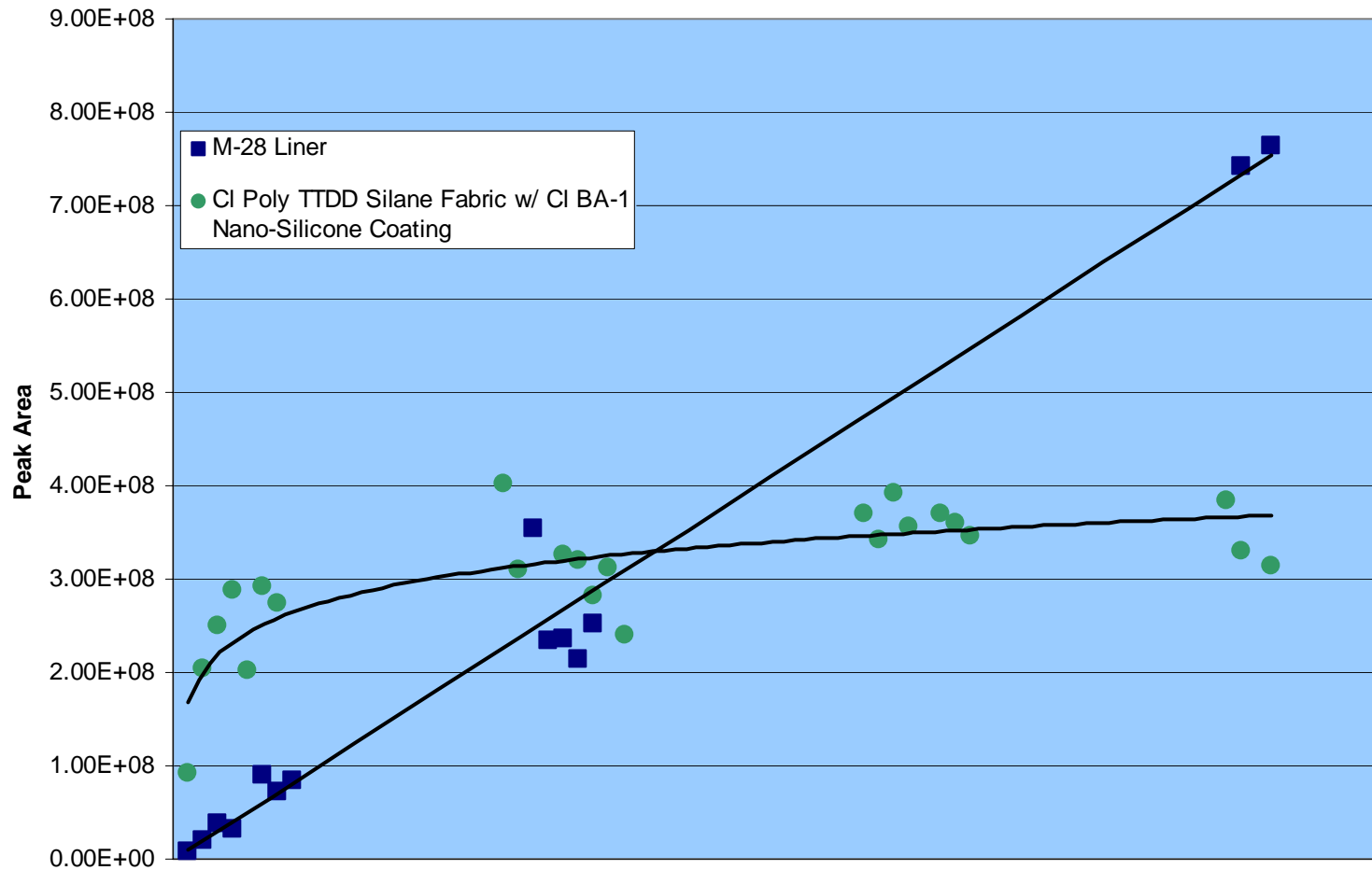
# M-28 Liner vs FI Silicone Coated Fabric: CEES

20g/m<sup>2</sup> Challenge



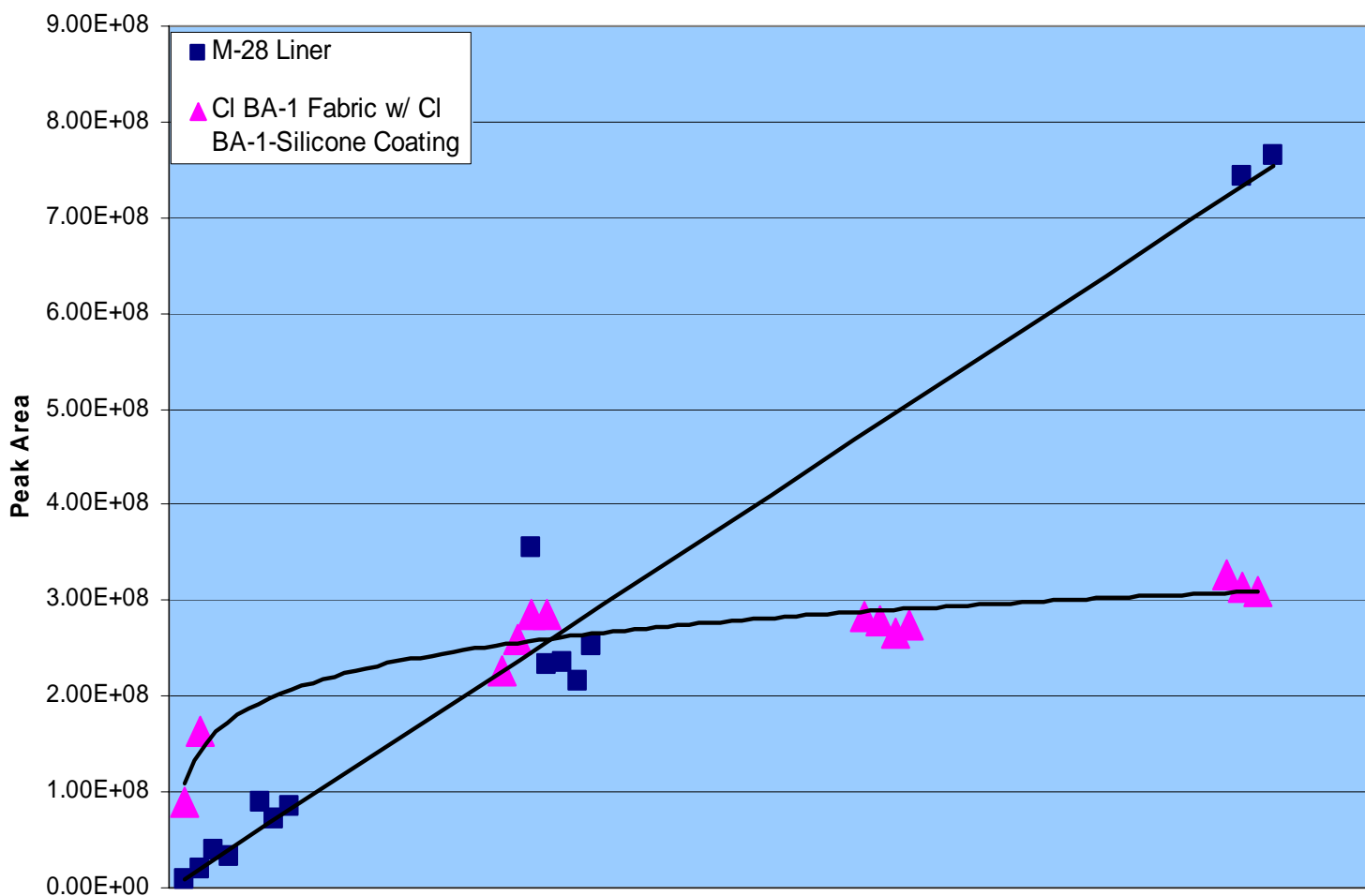
# M-28 Liner vs CI Poly TTDD Silane Fabric w/ CI BA-1 Nano-Silicone Coating: CEES

20g/m<sup>2</sup> Challenge



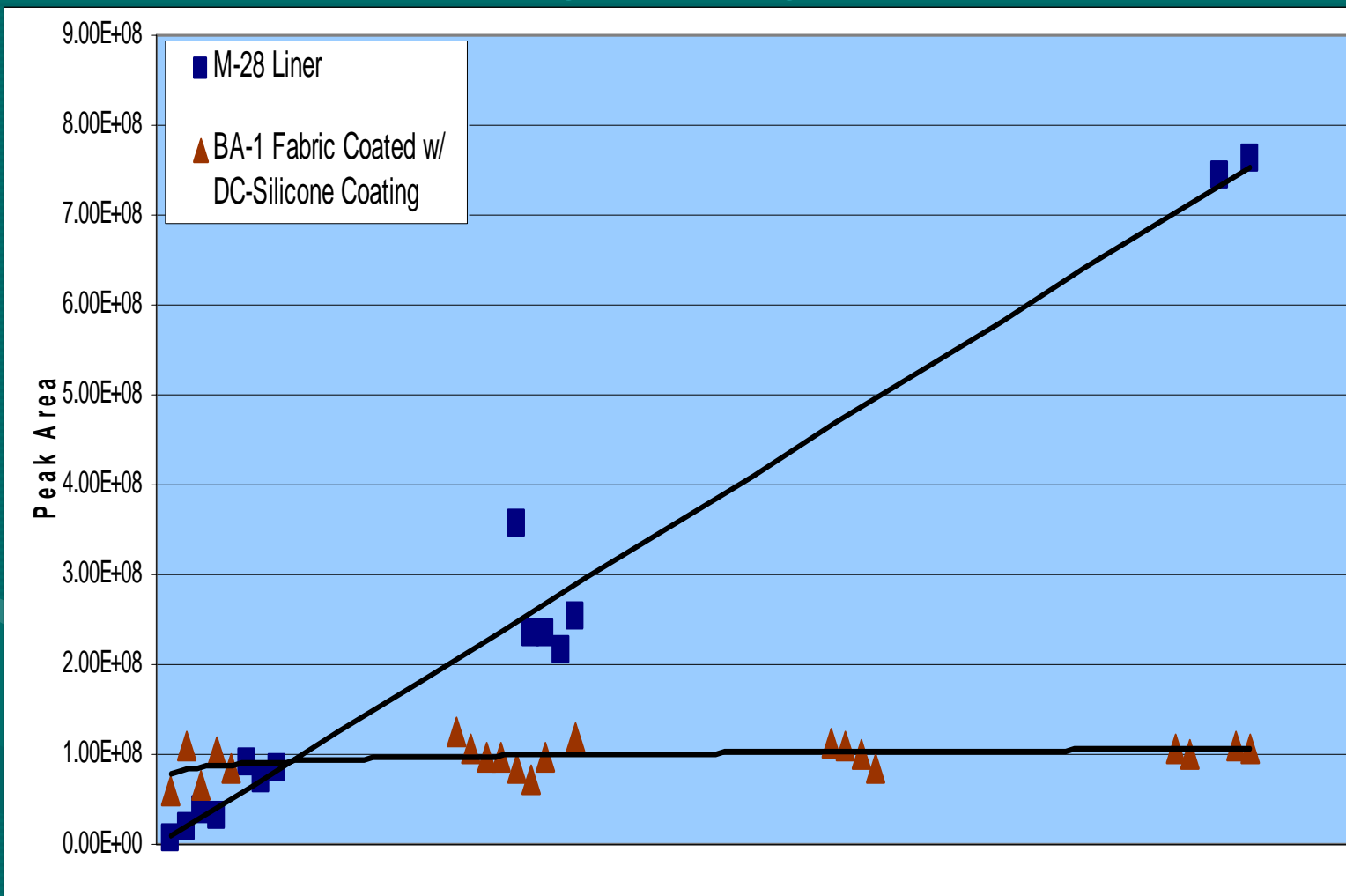
# M-28 Liner vs Cl BA-1 Fabric w/ Cl BA-1 Silicone Coating: CEES

20g/m<sup>2</sup> Challenge



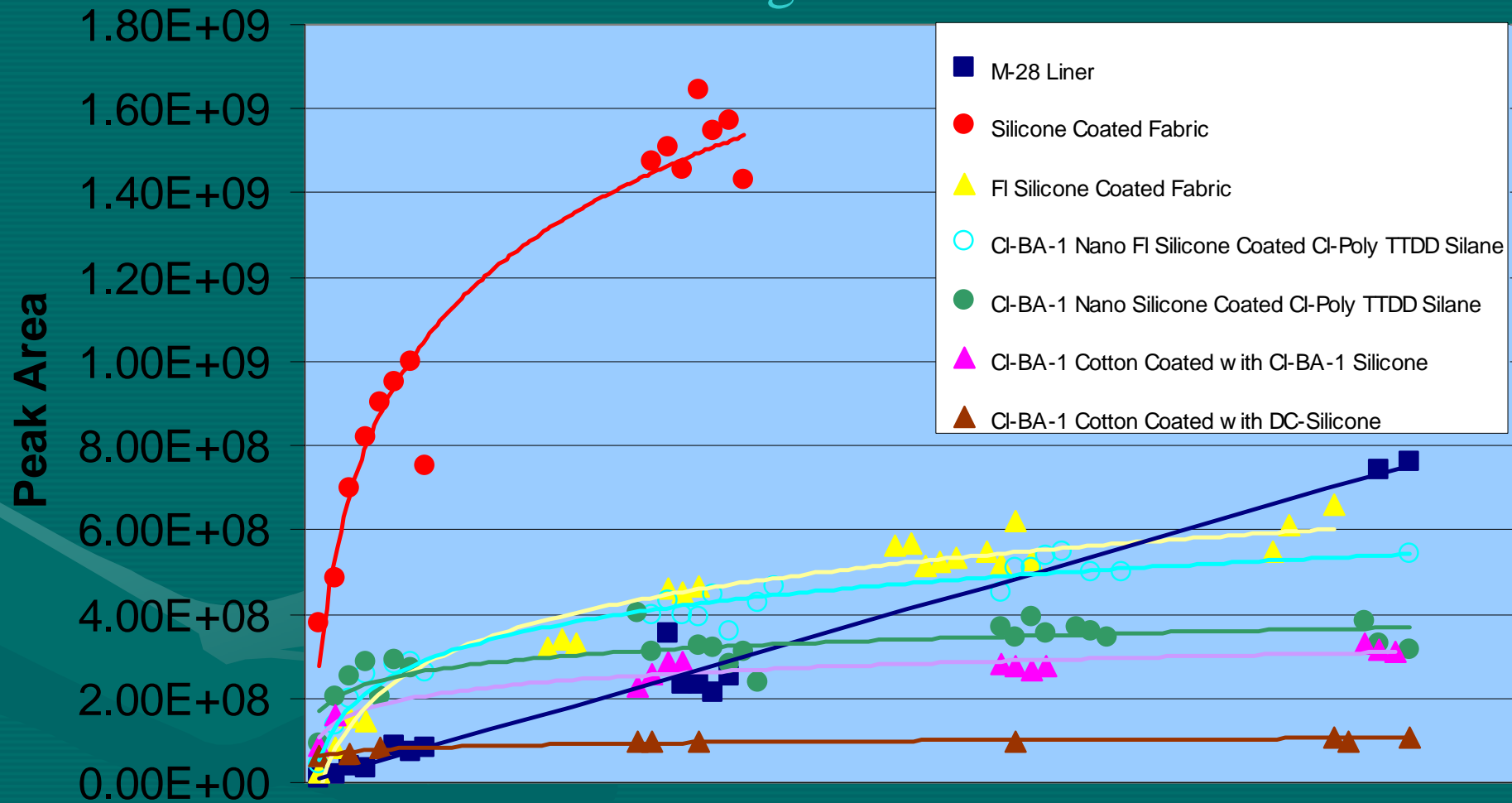
# M-28 Liner vs BA-1 Fabric Coated w/ DC-Silicone Coating: CEES

20g/m<sup>2</sup> Challenge



# Liner Materials Challenged with CEES

20g/m<sup>2</sup>



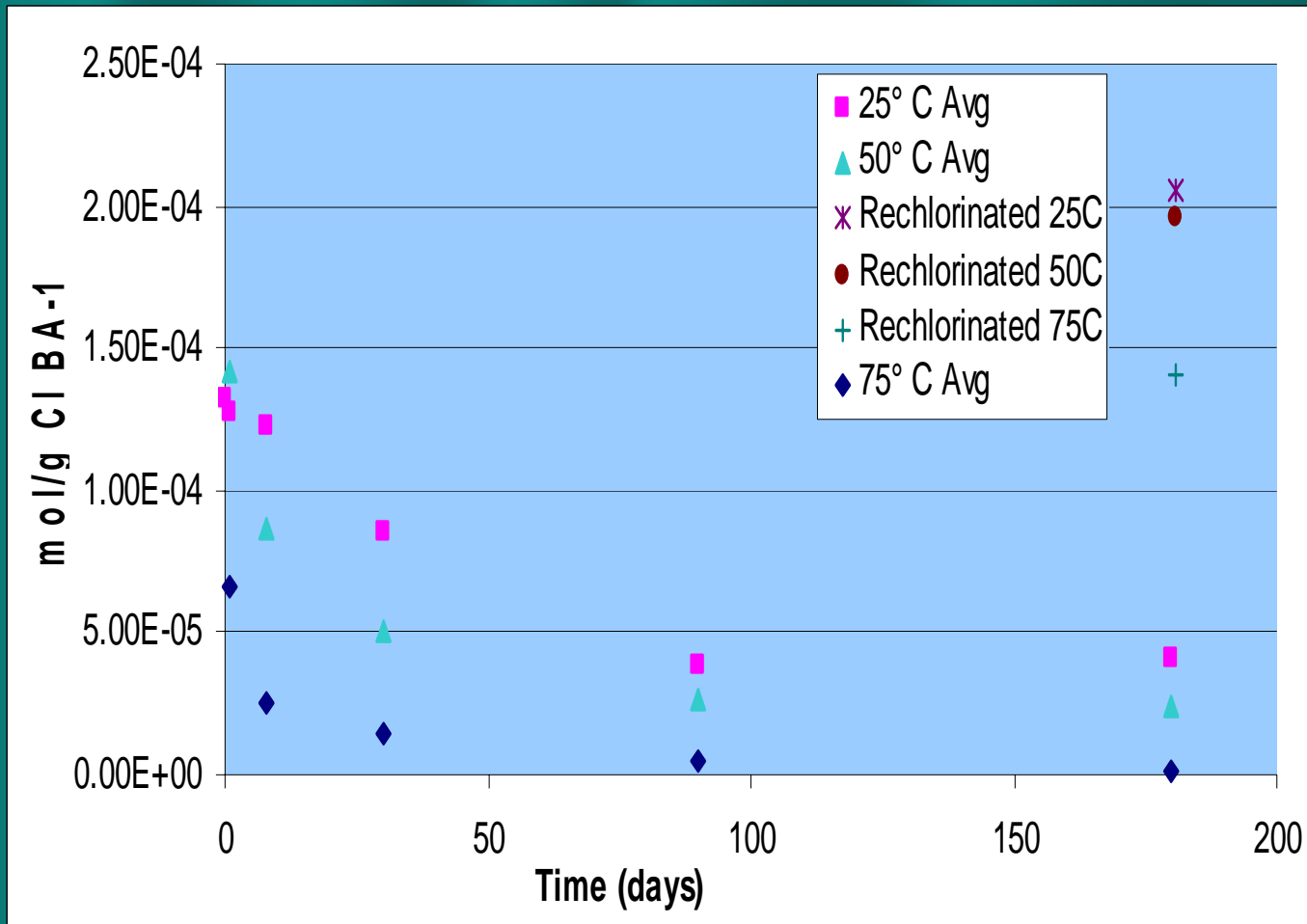
# Chloramides of the World...

## Regenerate!





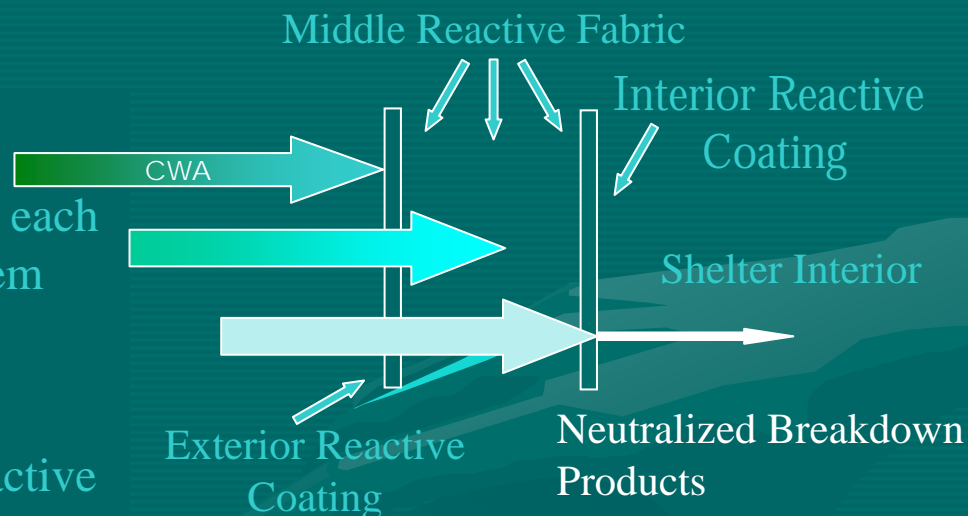
# Temperature/Regeneration Study



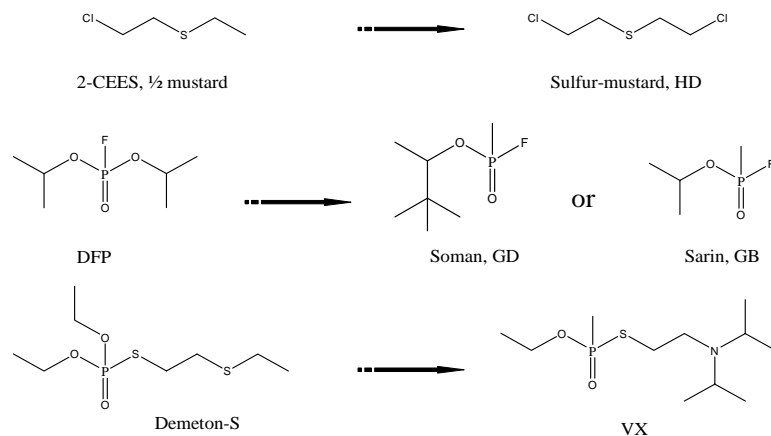
# Summary and Conclusions

## Reactive/Barrier Materials

- The defined Criteria For Success were met for each target CWA, therefore the reactive barrier system will outperform conventional barrier materials
- Shelter materials can now be made using less expensive barrier materials augmented with reactive coatings to provide increased protection
- Potential for expedient field-applied system to non-CB hardened structures
- Further simulant and agent testing is required



## Simulant/CWA Comparison



Questions?